Attention Management: A Survey

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Abstract: *Apart from the natural difficulties imposed by the execution of a task, other non-trivial, hard-to-predict issues might increase the time to complete it: the high number of interruptions caused by electronic devices, such as computers, PDAs and mobile phones, and by other people, who directly ask for attention. These interruptions, even the short ones, cause distractions that are hard to fix, due to the amount of time needed to switch attention back to the previous problem. This paper provides a survey of Attention Management, a field that aims to manage how and when such interruptions can occur.*

I. Introduction

As electronic devices are becoming more and more indispensable to everyone's life, the chances of one being interrupted in the middle of an important task execution have increased. These interruptions produce several shortcomings, the biggest one being attention breakdown. In order to resume the execution of the previous task, it is necessary to regain the lost attention, which might require a small or a considerable effort. Hence, as the number of interruptions increases, so does the amount of time required to finish a task.

Lately, names such as “Attention Economy” and “Information Overwhelming” began to appear. This can indicate that attention is becoming a commodity more important than physical and financial resources [18]. On one hand technology brings connectivity to people but on the other hand such connectivity is responsible for a quite large number of interruptions, breaking tasks into smaller fragments [43]. It should be kept in mind, though, that this is not the “divide and conquer” approach. The original task should be indivisible and any interruption brings down worker attention, which might require a considerable effort to be regained.

To reduce the overhead caused by the interruptions, several studies are being made on how to manage one's attention, trying to postpone attention demands until it is safe to the worker to be interrupted – as his cognitive work was already low. Such low-cost interruption periods are called *breakpoints* [32]. All previously mentioned factors are focus of Attention Management research, and thus are considered in this survey. In fact, Attention Management is a wide field of research, comprising even medical care and treatment.

This paper is organized as follows: section 2 presents important concepts and types, as well as how attention can vary. Section 2 also presents a brief introduction on Attention Economy. Section 3 lists and compares interruptions and breakpoints, and section 4 focus on the problems faced by Attention Management. Sections 5 and 6 discuss aspects related to information systems and how they fit in Attention Management, respectively. Section 7 lists some open trends that might become the focus of research groups. Finally, section 8 concludes the paper.

II. Attention Concepts

Viegas [45] defines attention as mental involvement when concentrated in any information item, trying to decide when an action is necessary. Attention is a cognitive process through which our mind selects stimuli, making connections among them. Information can productive whether the right amount of attention is required to absorb it – and then information can become money if used properly.

The human being is not capable to accomplish every single attention request he/she is exposed to in one day. Given the large amount of information resources (e.g. television, magazines, Internet, etc.) our brains are submitted to stress conditions which might be harmful [9]. Technology plays a central role in this scenario as the number of available resources is mostly due to technology innovations, e.g. mobile and smart phones. It becomes necessary to filter attention requests. But the open question is how to do it.

A. Attention Types and Behaviors

Besides the condensed Attention that selects and processes only one stimulus, there can also be a *shared* Attention, which processes multiples stimuli at the same time. To be effective, Attention depends on three factors [22]:

1. Physiological: depends on the individual's physical and neurological conditions;
2. Motivational: depends on the individual's interest on the subject;
3. Concentration: depends on the stimulus performance degree, leading to a better focus on its source.

Attention can also be divided into motor, intellectual and sensory. The first one is related to the execution of a physical activity, while the second one represents the capacity for resolving problems. Finally, the last one is related to senses such as smell, taste, etc...

Every person has an attention limit. If he/she gradually receives more and more tasks, then his/her attention is likely to become saturated. This way, Attention can be divided into units (Attention Units – AU), classified according to their behavior. Figure 1 illustrates attention behavior.

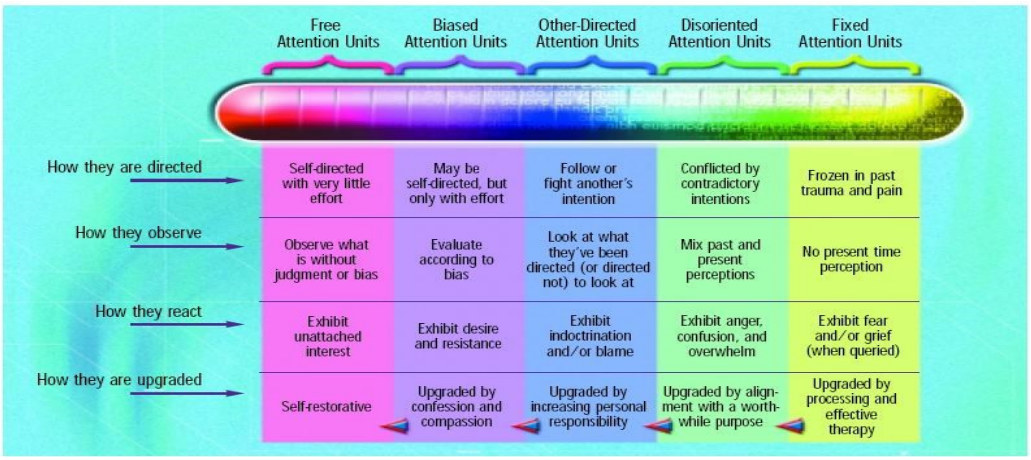

Figure 1: A scale of attention behavior

Beck and Davenport [5] suggest that Attention has at most 6 different divisions, as follows:

1. Aversive: when people are afraid of the consequences of not paying attention;
2. Attractive: when people pay attention to the subject because they want to do so;
3. Voluntary: when people pay attention to something they are interested in;

4. Resident: this type of attention happens when there is an external factor that helps people not to lose focus;
5. Front-of-mind: recent memory, high degree of attention required; and
6. Back-of-mind: ancient memory, low degree of attention required.

B. Attention Economy

The explosion of new types of online information is a double-edged sword. Everybody likes getting "drowned" in news, blogs, podcasts, photos, videos and Web pages belonging to sites like MySpace. This problem tends to increase as more people use the Internet over time.

The increase in available information complicates the act of maintaining attention. According to Herbert Simon, "the rapid growth of information leads to lack of attention".

The idea behind the Economy of Attention is simple. This economy facilitates the creation of a market where consumers agree to receive information in exchange for their attention. The ultimate goal is naturally to sell something to the consumer, but the selling need neither be direct, nor instantaneous. Search engines exemplify this situation in which they display ads in exchange for helping users find answers on-line [22].

Lacks of Attention is also a major problem for sites, blogs, search engines and other on-line mechanisms, also impacting on their finances. The sites that contain relevant content have a great incentive to be found and visited.

It is important to understand that the key point in the game's attention is relevance. Literally, the longer you remain on a site reading news, the greater is the chance of selecting an ad. So the question is: how to show the user the relevant content? This is a complex problem that is partially solved by the mechanisms of recommendation. However, it is not possible to produce custom content, unless they know certain characteristics of the user, such as which books one likes, what wine one drinks, etc.

Another key point in the Economy of Attention is privacy. The challenge is not only to give the consumers relevant content; but also to put the user in control of the information. In Figure 2 members of the Economics of Attention and its relations [22] are displayed.

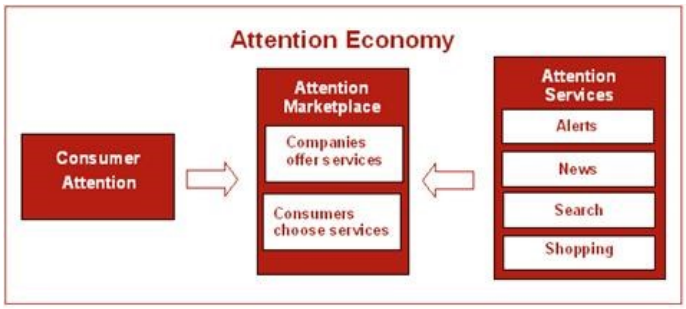

Figure 2: Modules of the economy of attention.

III. Interruptions and Breakpoints

According to Mark et al. [25], there are two types of interruption: external and internal. External interruptions are those that come from the working environment, such as a ringing phone, a co-worker stopping to ask a question, a warning of the arrival of e-mail, etc. Internal interruptions are those where a person stops a task at their own will.

Both internal and external interruptions affect the time to complete a task. Interruptions have different levels of importance [25]. Moreover, the environment affects the likelihood of sudden interruptions coming from the external environment.

People get interrupted with the same frequency with which they interrupt themselves [41]. Most

internal interruptions occur because people want to leave the workplace to interact with others. External interruptions occur frequently due to verbal events, such as visits, meetings and phone calls [15]. Table 1 shows the types of internal and external interruptions and their daily averages.

Table 1 - Average number and types of interruptions per day.

	Type	Average Interruptions/day	% All	Internal/External
Internal	Checking/Using Paper Docs	0.52 (0.86)	1.87	49.11 %
	Checking/Using Computer	1.54 (1.47)	10.98	
	Talking to walls	1.93 (2.15)	6.98	
	Phone call	1.14 (1.56)	4.09	
	E-mail use	1.04 (1.47)	7.40	
	Leaves cubicle	5.00 (2.56)	17.87	
External	New e-mail notification	3.55 (3.18)	12.68	50.89 %
	New e-mail notification	6.00 (3.03)	21.45	
	Status on terminals	0.36 (0.82)	1.28	
	Phone ringing	2.62 (2.01)	9.36	
	Voice message light	0.19 (0.45)	0.68	
	Call through wall	1.33 (1.75)	4.77	
	Reminder notification	0.19 (0.40)	0.68	
Total	-	25.40 (8.23)	100	100.00 %

Usually there are two mechanisms governing the completion of a task: interactions and initiative [25]. O'Conaill and Frohlich found that in 41% of interrupted tasks, the person does not go back to the interrupted task immediately [33], which may be completed later, on the same day. Hudson et al. [18] showed that managers prefer not to be interrupted at certain times of day, to complete their tasks more efficiently.

C. Interruption Costs

Adamczyk [2] says that the cost of an interruption comes from the potential degradation of performance in carrying out tasks that were interrupted. Research has been done on the factors for interruption cost, like frustration and distractibility [19], including the cost of repeated user annoyances and there is a belief that complex interruptions should have more weight than mere interruptions [12]. Different methodologies for estimating the cost of interruptions were used. There is also research that considers the problem of the cost of interruption as a problem of economic theory [26], which seeks to minimize the expected cost, maximizing expected productivity. The process itself is associated with a cost and the opportunities are associated with a stationary distribution function [38].

D. Breakpoints

Newtson [32] defines a breakpoint as a moment of transition between two observable and significant units of a task, which reflects the internal transitions for perception or cognition. Observable and significant task units follow the concept of granularity which refers to the actions that can be taken on a breakpoint [46]. There are at least three significant granularities: large, medium and fine [13, 20, 21, 46, 47].

Generally, these breakpoints are seen by observers, which try to identify the exact moment in

which a task ends and the next begins. It is important to emphasize that observers may increase or decrease the granularity of their analysis [32].

i. How to Use Breakpoints

The main use in the detection of breakpoints is to know the right moment to introduce new attention demands that would cause interruption if they are not remedied. Then, the majority of interruption costs would be mitigated [1, 4, 17, 20] as new task demands would occur in the moment of transition of cognition. When working with a large granularity, in other words, with big tasks changes, breakpoints should be used as interruption opportunities [20].

Breakpoint detection is a way for a new class of tools which allow knowledge activities to be organized in shared and reusable forms [11, 39]. The ideal would be the operating system of a device or a computer to offer a service that manages activities for all applications. A challenge to build this tool is to organize the user's actions without requests [11].

ii. Detection Methods for Breakpoints

Detection methods for breakpoints change according to target application. The most common and generic methodology is the structural decomposition of the task, using GOMS [7] or its variant [21]. These methodologies create structures that allow identifying the passage of one task to the next, that is, a breakpoint [3].

A method implemented in computer systems uses the number of windows of applications in a window time slide as an indicator of change of activity [31]. This method maps that change in large granularity. Its effectiveness ranged between 20% and 90% and only one kind of breakpoint could be detected [21]. Another method used in this area is the virtual window manager [16]. This method also recognizes only one type of breakpoint and forces the user to use his window manager [21]. There are also statistical models on the interruptible in interactive tasks [13], which found the time of the user's breakpoint [21].

In a method used in mobile devices, Ho and Intille [17] used several accelerometers on the body of a person. Thus, they could monitor the person and detect moments of physical transitions, such as lifting, sitting, walking, or running. Using these transitions as breakpoints, the costs of interruptions could be considerably reduced [21].

E. Breakpoint X Interruption

It is important to distinguish between a breakpoint of an interruption. Despite the fact they had similar characteristics, they are essentially based on different concepts.

Breakpoints always occur at the end of a task regardless of their granularity. They are opportunities to perform the interruption, as they occur when the cognitive effort is minimal.

The interruptions can happen from zero onwards during the execution of a task and involve double cognitive costs: one, to perform the task that was interrupted, and to return subsequently to the task that was interrupted.

When using breakpoints as opportunities to deal with interruptions, the highest granularity ones are better for the gain in performance to complete the tasks. Figure 3 shows a graph with the mental burden of a person for a period of time. Minimum points are the breakpoints.

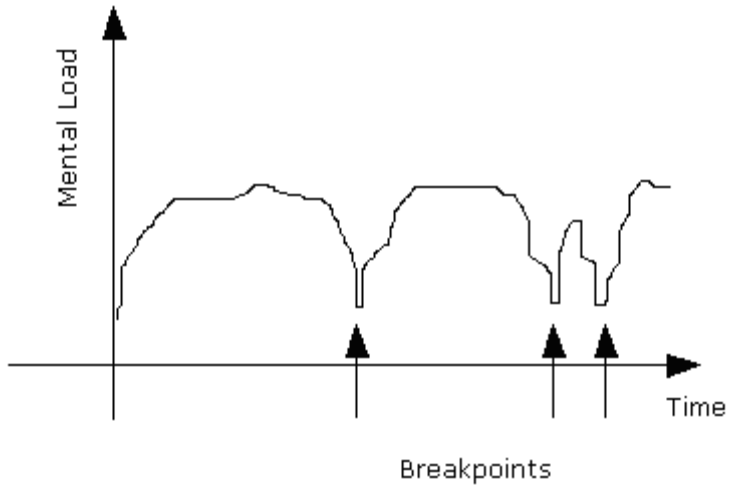

Figure 3: Identification of the mental load level on the occurrence of breakpoints.

IV. Problems in Attention Management

F. Work Fragmentation

The Work fragmentation is defined by Mark et al. [25] as a break of a continuous activity. There are two aspects of work fragmentation: the continuous execution time of an activity and the activity interruptions.

As the number of interruptions increases, the time required to perform a single task grows, with rare exceptions. There are cases of many large interruptions, for very different activities or cascade interruptions in which we need to remember the state of several tasks that already have been started. Sometimes, task change can be beneficial as it can help a person relax and have new ideas and approaches to finish the blocked task.

Often it is necessary to have warm-up (or start-up) time for a person to focus on the activity. Therefore, spending a very short time in an activity becomes a huge waste of time, caused by the multiple overheads of focus change. The time loss implies directly in low productivity.

Several studies carried out in workplaces describe how workers who deal with information spend their time performing various tasks, usually broken into short time intervals due to interruptions caused by other people. Employees who usually are the target of these studies on interruption [8, 18, 33, 37] are managers [18, 28, 41], financial analysts [15], software developers [34] and even telecommunication professionals [23].

G. Employees' Localization

According to Mark et al. [25], there are several reasons why employees who work at a fixed location (e.g. in an office) have greater task fragmentation than those of who work in a distributed manner.

An advantage of grouped employees is the spontaneous and opportunistic interactions, in which information helps work coordination [24]. A disadvantage is the greater amount of task interruption, often to adapt themselves to the activities of their co-workers [25].

The opposite occurs with distributed employees. They lose the advantage of rich interaction, but on the other hand, are less interrupted. So, they can finish their tasks faster.

H. Info Stress Syndrome

The limitations on attention have always been a problem to Man. With the rapid development of

new information technologies this problem gets tougher every day. For this reason a very special phenomenon is reported, having been experienced by Humanity due to the contrast between the abundance of information and a limited capacity of attention. This phenomenon has been called by the Americans clutter effect, producing a decline of the value in information as attention is compromised, when faced with excessive information, and becoming inefficient [30].

On one side we have information over-stimulation, and on the other side people who always need to be very well informed and updated. Meanwhile, our baggage of attention is not enough to be always updated. This has led human beings to having adverse reactions, expressed through psychosomatic symptoms, such as a reduced ability to concentrate, irritability, sweating, tiredness, dispersion, attention deficit or with consequential difficulties in decision-making, etc. This set of symptoms and reactions has been given the name of Info Stress Syndrome.

V. Information Technology in Attention Management

I. Attention Technology

The concepts and principles of Attention Economy are attractive, but are they feasible? Attention technology and architecture play an important role in facilitating the market. A set of standards and protocols should be the basis of Attention Economy Technology. Figure 4 presents the outline of the architecture for Attention Economy [22].

According to the draft, both Implicit Attention and Explicit Attention are captured and stored in a database. Users have control over the system for the collection of attention to their use. The user can also choose where to store data using a standard protocol.

The information from users that is stored in the database can be accessed through attention services. These services can take the user to obtain benefits by providing personalized information. According to the technical point of view, the key to facilitating the attention of the market is to disconnect (unlink) the services for the capture, storage and recording of attention.

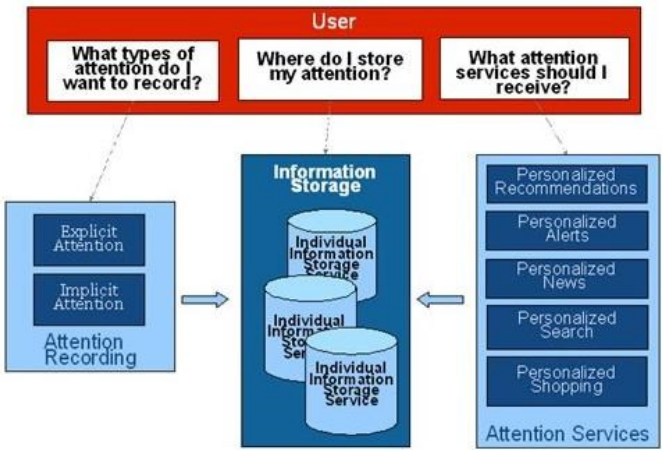

Figure 4: Architecture for the attention economy.

J. The Internet in the Attention Economy

The Information Age has contributed to a world swamped by too much information and troubled by the lack of time people have, creating a major challenge for companies: how to maintain and manage the attention of people? Attention is now the most important current value to the business and managing attention is a crucial activity for success in today's business scenario [9].

In the marketing context, the Internet is an important tool to disseminate and draw the attention of the market to its products, influencing people to acquire them. The use of the Internet in managing brands is vital to the context of Attention Economy. Products gain more attention and emphasis in the market if there is a relationship of identity, relevance and passion between the

audience and the brand name.

Demand behavior in the Internet, Attention Economics, should be studied. When entering a Web site, the consumer is defining what one wants to see and for how long. The volume of visits, the average length of stay, the number of activities carried out during navigation, and frequency with which people return to the website is data through which we can see more about who is paying attention spontaneously to it and all in real time.

Online communities (virtual groups) are the venues where consumer-to-consumer marketing takes place, and where the traditional word-of-mouth referrals occur. This is the perfect environment to capture the attention from the moment that there is a relationship between the company and online community. This has led companies to create their own online communities to learn more about their consumers, loyalty, and to manage the attention of these people. E-commerce is another factor determining a strategy for attention managing, because of the online sales and after sales process, and when implemented, allows the management of purchasing habits in a large scale for retail activities.

The Internet is not the solution to align a business to a business environment created by the Economics of Attention. We should consider various practices, processes, strategies and attitudes. But the fact is that the Internet has important tools to form a comprehensive set of strategies and actions to interact, learn, acquire and retain consumers. In the future, new ways of doing business will still appear there but it is essential that companies are now aligned with these new trends, to seize the opportunities and minimize the threats in this new scenario..

K. Attentive Interface and its Characteristics

Vertegaal [42] defines an Attentive Interface as an interface that prioritizes the information that is presented to its users, through the resources of processing information both of the user as of the system, optimally distributed among a set of tasks. To achieve this goal, the interface needs a basic knowledge - a combination of measurements and models – of the state of the user's attention in the past, present and future, taking into account the availability of system resources.

According to Smith et al. [40], it is reasonable for the developer of windowed systems that the user will focus on a higher-priority task, in a context where there are other lower-priority tasks. In graphical interfaces, the relevant window should occupy the space on the computer screen. Lower-priority tasks are represented by icons and occupy a peripheral part of the computer screen [42].

Selecting a window or icon with the mouse, the user not only optimizes the value of the information, according to one’s attention, as well as transfers it to the computer. Systems that seek information on the intention of their users tend to be more proactive, for example, the modern systems for traffic light control. In information and telecommunication system networks, such as e-mail, the structure of the notification associated the Attentive Interfaces would be even more relevant [42].

Windowed systems in a graphical interface have no means of measuring the state of user attention implicitly, but let the user explicitly tell their state of attention due to the manipulation of the system. This allows the interfaces to classify it as implicit or explicit. Systems are typically explicit windowed mode systems and systems that use sensor technologies and follow the movement of the eyes to measure the state of user attention are classified as implicit [42].

According to Vertegaal [44] systems that employ implied measurements can use a combination of the user's presence, guiding the body, head and eyes to determine the state of attention. An important feature is that the system stores some of these variables in a model.

L. Attentive User Interfaces

Attentive User Interfaces (AUIs) are human-computer interfaces that are sensitive to user attention [43]. AUIs are based on the metaphor of lights to indicate the best time to start a demand that requires the attention of the user.

This type of design has become necessary with the evolution of computing, as shown in Figure

5. In the 60s and 70s, several people used a mainframe. In the 80s, each person started on the PC road. In the 90s a person uses various devices. Since 2000, people have had to interact with various people and various devices.

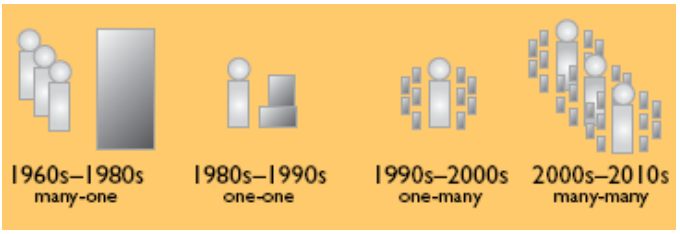

Figure 5: The evolution of the use of computational devices.

Designers and engineers of human-computer interfaces are beginning to create computing devices that negotiate rather than impose the volume and timing of communication with the user [43]. These negotiations are made using signals between the devices, as traffic lights, which determine the priority of the devices in relation to the user. There are models of AUIs that measure and shape the focus of the user to define the priority of the devices in relation to access to the user.

For the implementation of AUIs we need more entries, which are interpreted and generate as output the priority and time to demand attention. As inputs, various types of sensors can be used, such as presence, proximity, guidance, speech, and vision. Based on this data, devices can infer some knowledge on the priorities that govern the user attention [43].

To display the necessary behavior, AUIs provide information on the users' attention to people or remote devices [43]. These interfaces are known as Attention-Based Systems or Conscious Systems [43].

VI. Attention Management Applications

M. Support for Attention in Collaborative Virtual Environments

The advent of modern Information and Communication Technologies (ICT) has facilitated the access to information and the communication between people, but it has generated information in abundance. This has had a direct impact on the processes of knowledge creation, which requires careful management, individual and collective of attention resources [9].

Shared virtual environments have increasingly incorporated means to support the complex interactions and new channels of power interruption that have become an almost constant item in many working environments and for learning.

While the interruptions may eventually provide useful information for the development of tasks, it has been widely observed that the increase in interruptions requires more attention. And the reloading of attention that becomes necessary can generate stress and undermine the performance of the task, especially when the user is working with portable devices in mobile environments [9].

Studies in cognitive psychology have established that the allocation of attention depends on the perception about the deliberative processes. Based on the principles that guided these studies, Roda [35] proposed that the attention in virtual environments is supported on four levels:

1. On the perceptual level, facilitating access to relevant information or giving breaks to the appropriate level of notoriety.
2. On the deliberative level, providing tools to control priorities of work, or motivating users who are without focus.
3. On the operational level, users can simply be supported by some operations related to attention, such as restoring the context of the tasks interrupted, or the filtering of incoming messages.

4. On the "meta-cognitive" level users can be supported in their thoughts on how to allocate attention, for example, providing tools for themselves.

On the first level, media attention means to increase the ability to notify relevant information and discard irrelevant information. There are four ways to highlight perception [35]: 1) facilitating the selection of relevant information, 2) facilitating the understanding of the information, 3) Supporting the perception of the group and, 4) presenting the interruptions on the correct level of relevance.

The selection of attention can be facilitated by the use of filtering information and viewing mechanisms. This process may occur in a static or dynamic manner, using simple or sophisticated algorithms or in the case of social filtering, one can use the evaluation related to the man who ranks or attaches standards for various items. Viewing mechanisms can be attached or replaced by the presentation of information on non-visual methods through multiple channels that are used to communicate with the user [35].

When people are learning or performing group tasks, their activities influence the perception of the group and the focus of attention of every individual as follows: 1) the dedication of attention to some activity may be necessary to ensure the smooth functioning of the group as a whole (as in cases where there is the allocation of attention to a task, because the completion of this task is a prerequisite for the activity of other group members), 2) pressure mechanisms may result in the diversion of the attention of its natural course, 3) the decision to stop the activity of other people can be guided by social, social rules and knowledge signals about what the other person is doing, 4) presentation of interruptions in the appropriate level for notoriety may significantly reduce the load on the level of perception. This may be done by sending e-mail or an instant message, posting a message in a chat room, presenting an item on the main page of a portal, placing a flashing icon, or including a situation the user is in at the time (busy, answering a message, etc.).

On the second level, the deliberative, attention is influenced by their goals, motives and intentions, in addition to the perceptive and deliberative processes that constantly interact to determine a state of attention. The attention on the deliberative level should be supported considering the situations in which the user [35]:

1. Loses motivation and/or if there is an interruption in the search for a more adequate focus.
2. Loses the sequence for planned activities and/or if there are difficulties in prioritizing activities.
3. Cannot use the resource and time or if there is loss of the timeline.
4. Have difficulties in choosing the best solutions to align the focus of the group.

The loss of motivation, along with fatigue, is one of the main reasons for the loss of the focus of attention. The implementation of multitasking and interruptions not only imposes a burden related to cognitive memory of what was happening when there was a resumption of the task, but also creates the problem of maintaining a clear idea of other important tasks that occur then. Another consequence is the increasing difficulty in selecting the information or the task that is more appropriate to meet the time available.

In collaborative environments, the community moderator role entails being able to identify the information and tasks that are relevant to the whole group. In an exact attention system this can be found in at least three types of actions [35]:

1. Knowing the interdependence between the tasks, the system should know about dependent tasks, those carried out by different group members, and be able to suggest to the member of the group the attending of a task that is critical for the actions of other group members.
2. Investigate the access and actions on the documents, the system should be able to inform group members on what actions should receive more attention.
3. 3In multi-user collaborative environments, the delay in or minimizing of the impact of the notification of a message in order to optimize the performance of a user, resulting in lower than expected performance for the group as a whole (as in cases where the activities of other

group members depend on the prompt notification and reaction).

N. Attention Management in Knowledge Management

Knowledge Management spreads knowledge in organizations in four processes [14]: creation, organization, development, and distribution of contents. To carry these processes out, the organization needs an infra-structure of tools to promote the sharing of tools and knowledge.

The organizational infra-structure for KM practices requires new roles and responsibilities [10]. These roles include Knowledge Managers, who need to understand the knowledge and apply it to the business, and use motivational factors to stimulate people to create, use and share the knowledge in an effective way.

Several technologies try to help obtaining and sharing knowledge. In KM, the human capital is a very important factor and, in some circumstances, besides the technology use, an expert or a knowledge analyst can be the best option [6].

KM importance tends to grow, becoming a primary factor to success and survival of an organization. One future challenge of KM is the Attention Management. The human attention is a natural limiter of KM. Knowledge, besides its value, become useless if it does not receive appropriated attention. Understanding how people allocate their attention is a factor that will help to solve knowledge issues. We need to learn how to capture attention, keeping the focus in relevant information and knowledge, using technology as a tool [10]. Attention is the future of business, and is the rarest of organizational resources. Beyond traditional KM techniques, organizations will need to focus their attention on attention.

Attention Management is a way to obtain success in KM, through the management of human capital. In the future, organizations will realize that the most important organizational factor is its knowledge, and this knowledge is created and applied by the human mind. Managing knowledge is managing people; managing people is managing knowledge [10].

O. Attention Management in Cognitive-Behavioral Treatment

Among the psychological treatments of chronic pain, Cognitive-Behavioural Treatment (CBT) is the most common. One of CBT's activities is AM.

Morley, Biggs and Shapiro [29] developed an AM-based prototype CBT for chronic pain patients. Probably, many of these patients already used some techniques unconsciously.

According to the Rene Descartes' pain model [29], pain signals can be interrupted or adapted by psychological processes using AM strategies. AM can be used to obtain a pain limiter by focusing the attention to other stimuli. The objective of AM is to help the patient "turn off" pain.

AM techniques require practice. Once developed, they shorten the suffering caused by pain.

Attention control can be kept through concentration, learning to focus on details that are not usually perceived. Exercises are used in the learning process for attention control. One of them is to establish a focal point, an object, a thought or specific feeling that dominates attention. Patients can, using AM, raise their awareness enough to deal with pain [29]. To measure the efficiency of AM in patients, a set of metrics [29] is used. Global estimators on attention related to pain are not frequent.

There are two AM methodologies [29]. The first one stimulates the use of AM activities by patients suffering unbearable pain, to get over the pain, changing its focus. The second one is focused on AM and pain management as the fundamental way to change the relationship with pain, changing patient threshold for pain. It is important to remember that AM is not a cure for chronic pain patients, but an attempt at reducing patient suffering, allowing people to live a fuller life [29].

VII. Challenges and Conclusions

Iskold [22] showed that Attention Economy is coming up despite several complex issues. The Web economy and information growth are leading us toward Attention Economy. Understanding the problems and using the correct technology is important to ensure a healthy future market. To do it,

some important issues must be considered:

1. Information users should be free to act.
2. The industry must create a forum that rules over Attention Economy.
3. People need to be educated on the value of their attention and the principles of Attention Economy.

These challenges are not simple and will take time to be solved. The industry forum is already considered a crucial point to accelerate the creation of rules and infra-structure for attention economy. Also, a large number of small companies are building services for attention.

In this work, AM is an important aspect for all steps of KM process. The growing number or mobile devices raised the number of task interruptions and task costs.

Excessive attention demands are a problem to people and, consequently, to Economy. In this context, managing attention becomes interesting. Information Technology is one cause of this overload and its solution.

For these reasons, we have a growing need to develop and understand AM, to consolidate its use in organizations. AM has several applications, from CSCW to CBT.

Acknowledgements

This work was partially financed by CNPq and SERPRO – Brazil.

References

[1] Adamczyk, P.D.; Bailey, B.P. If Not Now When? The Effects of Interruptions at Different Moments within Task Execution. CHI, 2004, 271-278.

[2] Adamczyk, P.; Iqbal, S.; Bailey, B. A method, system, and tools for intelligent interruption management. In TAMODIA ’05, pages 123–126, New York, NY, USA, 2005. ACM Press.

[3] Bailey, B.P.; Adamczyk, P.D.; Chang, T.Y.; Chilson; N.A. A Framework for Specifying and Monitoring User Tasks. Journal of Computers in Human Behavior, 22 (4), 2006, 685-708.

[4] Bailey, B.P.; Konstan, J.A. On the Need for Attention Aware Systems: Measuring Effects of Interruption on Task Performance, Error Rate, and Affective State. Journal of Computers in Human Behavior, 22 (4), 2006, 709-732.

[5] Beck, J. C.; Davenport, T. H. How corporate leaders can help their companies manage the scarlest resource of all: Attention. <http://www.accenture.com/home/default.htm>. Accessed: May 2008.

[6] Bergeron, B. Essentials of Knowledge Management. Wiley Press. 2003, Cap.5.

[7] Card, S.; Moran, T.; Newell, A. The Psychology of Human-Computer Interaction. Lawrence Erlbaum Associates, Hillsdale, 1983.

[8] Czerwinski, M.; Horvitz, E.; Wilhite, S. A diary study of task switching and interruptions. Proceedings of CHI 2004, 175-182.

[9] Daveport, T.H.; Back, J. C. The Attention Economy: Understanding the New Currency of Business (Paperback). Harvard Business School Press. 2002, 272p.

[10] Daveport, T. H.; Völpel S .C. The Rise of Knowledge Towards Attention Management. Journal of Knowledge Management. MCB University Press. 2001, 212-221 p.

[11] Dragunov, A.N.; Dietterich, T.G.; Johnsrude, K.; McLaughlin, M.; Li, L.; Herlocker, J.L. Tasktracer: A Desktop Environment to Support Multi-Tasking Knowledge Workers. Proc. IUI, 2005, 75-82.

[12] Fleming, M.; Cohen, R. A decision procedure for autonomous agents to reason about

interaction with humans. In AAAI Spring Symp. on Interaction between Humans and Autonomous Systems over Extended Operation, 2004.

[13] Fogarty, J.; Ko, A.J.; Aung, H.H.; Golden, E.; Tang, K.P.; Hudson, S.E. Examining Task Engagement in Sensor-Based Statistical Models of Human Interruptibility. CHI, 2005, 331-340.

[14] Garvin, D. A; March, A. A Note on Knowledge Management (Note). Harvard Business School Press. 1997, 20 p.

[15] Gonzalez, V.; Mark, G. "Constant, Constant, Multi-tasking Craziness": Managing Multiple Working Spheres. Proceedings of ACM CHI'04, 113-120.

[16] Henderson, A.; Card, S.K. Rooms: The Use of Multiple Virtual Workspaces to Reduce Space Contention in a Window-Based Graphical User Interface. ACM TOG, 5 (3), 1986, 211-243.

[17] Ho, J.; Intille, S. Using Context-Aware Computing to Reduce the Perceived Burden of Interruptions from Mobile Devices. CHI, 2005, 909-918.

[18] Hudson, J.M.; Christensen, J.; Kellogg, W.A; Erickson, T. "I'd be overwhelmed, but it's just one more thing to do:" Availability and interruption in research management. (2002). Proceedings of CHI 2002, 97-104.

[19] Hui; B.; Boutilier, C. Who's asking for help?: a bayesian approach to intelligent assistance. In IUI '06, 2006.

[20] Iqbal, S.T.; Bailey, B.P. Leveraging Characteristics of Task Structure to Predict Costs of Interruption. CHI, 2006, 741-750.

[21] Iqbal, S.T.; Bailey, B.P. Understanding and Developing Models for Detecting and Differentiating Breakpoints During Interactive Tasks. Proc.CHI 2007, 697--706.

[22] Isokold, A. The Attention Economy: Na Overview. <http://www.readwriteweb.com/archives/attention_economy_overview.php>. Accessed: May 2008.

[23] Jackson, M. What's Happening to Home? Balancing Work, Life, and Refuge in the Information Age. 2002. Notre Dame: Sorin.

[24] Kraut, R.; Fish, R.; Root, R.; Chalfonte, B. Informal communication in organizations: Form, function and technology. In Backer, R. (Ed.) Readings in Groupware and Computer Supported Cooperative Work. Morgan Kaufmann, CA, 1993, 287-314.

[25] Mark, G.; Gonzalez, V.M.; Harris, J. No Task Left Behind? Examining the Nature of Fragmented Work. CHI, 2005, 321-330 p.

[26] McMillan; J.; Rothschild.; M. Search. In Robert J. Aumann and Amsterdam Sergiu Hart, editors, Handbook of Game Theory with Economic Applications, pages 905–927. 1994.

[27] Milewski, A.E.; Smith, T.M. Providing Presence Cues to Telephone Users. in Whittaker, S. and Kellogg, W. eds. Proceedings of the Computer Supported Cooperative Work (CSCW) 2000 Conference, ACM Press, Philadelphia, PA, 2000, 89-96 p.

[28] Mintzberg, H. The Nature of Managerial Work. Englewood Cliffs N.J., Prentice Hall, 1973.

[29] Morley, S.; Biggs, J.; Shapiro, D. Attention Management in Chronic Pain: a Treatment Manual. 1999, 64p. <http://www.leeds.ac.uk/lihs/psychiatry/attman/introduction.htm>. Accessed: May 2008.

[30] Moura, A. H. de ; Santos, N. R. dos. A Economia da Atenção no Marketing Industrial. <http://www.ddic.com.br/arquivos/outros/A%20Economia%20da%20Atencao%20no%20mkt.pdf> Accessed: May 2008.

[31] Nair, R.; Voida, S.; Mynatt, E. Frequency-Based Detection of Task Switches. Proceedings of the 19th British HCI Group Annual Conference, 2005, 94-99 p.

[32] Newtson, D. Attribution and the Unit of Perception of Ongoing Behavior. Journal of Personality and Social Psychology, 28 (1), 1973, 28-38.

[33] O'Conaill, B.; Frohlich, D. Timespace in the Workplace: Dealing with Interruptions. in Proceedings of Human Factors in Computing (CHI '95), ACM Press, Denver, CO, 1995, 262-263.

[34] Perlow, L.A., The time famine: Toward a sociology of work time. Admin. Science Quarterly, 44, (1999), 57-81.

[35] Roda, C.; Nabeth, T. Attention Management in Virtual Community Environments. Journée de recherche de I'AIM – Innovation et Systémes d'Information – 6 octobre 2006.

[36] Rodenstein, R.; Abowd, G.; Catrambone, R. OwnTime: A System for Timespace management. in Human Factors in Computing Systems: Proceedings of CHI '99, ACM Press, Pittsburgh, PA, 1999.

[37] Rouncefield, M.; Hughes, J.; Rodden, T.; Viller, S. Working with "constant interruption": CSCW and the small office. Proc. CSCW'94, 1994, 275-286.

[38] Sarne, D.; Grosz, B. J. Sharing experiences to learn user characteristics in dynamic environments with sparse data. In AAMAS'07, 2007.

[39] Shen, J.; Li, L.; Dietterich, T.; Herlocker; J. A Hybrid Learning System for Recognizing User Tasks from Desktop Activities and E-mail Messages. Proc. IUI, 2006, 86-92.

[40] Smith, D.; Irby, C.; Kimball, R.; Verplank, B.; Harslem, E. Designing the Star User Interface. Byte 7(4), 1982, pp. 242-282.

[41] Sproull, L.S. The Nature of Managerial Attention. in Advances in Information Processing in Organizations, JAI Press, 1984, 9-27.

[42] Vertegaal, R. Designing attentive interfaces, in: Proc. of the Eye Tracking Research & Applications Symposium, New Orleans, LA, 2002, pp. 23–30.

[43] Vertegaal, R. Attentive User Interfaces: Introduction, Communications of the ACM, v.46 n.3, March 2003.

[44] Vertegaal, R.; Veliehkovsky, B.; Van der Veer, G.C. Catching the Eye: Management of Joint Attention in Cooperative Work. SIGCHI Bulletin 29(4), 1997.

[45] Viegas, S. Gestão da Atenção. <http://www.via6.com/topico.php?cid=6183&tid=167674>. Accessed: May 2008.

[46] Zacks, J.; Tversky, B.; Iyer, G. Perceiving, Remembering, and Communicating Structure in Events. Journal of Experimental Psychology: General, 130 (1), 2001, 29-58.

[47] Zacks, J.M.; Tversky, B. Event Structure in Perception and Conception. Psychological Bulletin, 127, 2001, 3-21.